



Optical design of absorber materials for reduced H-V CD bias in EUV Lithography

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Simulation condition



Introduction



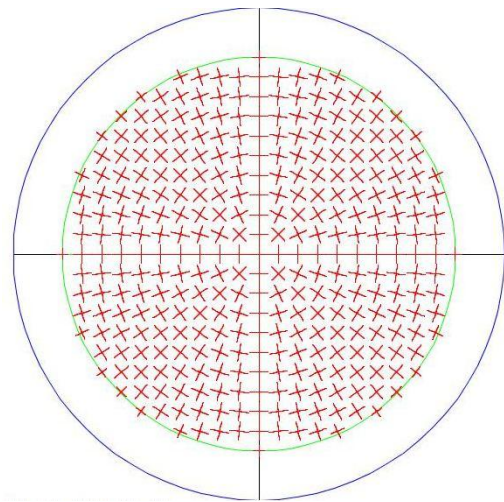
Experiment



Conclusion



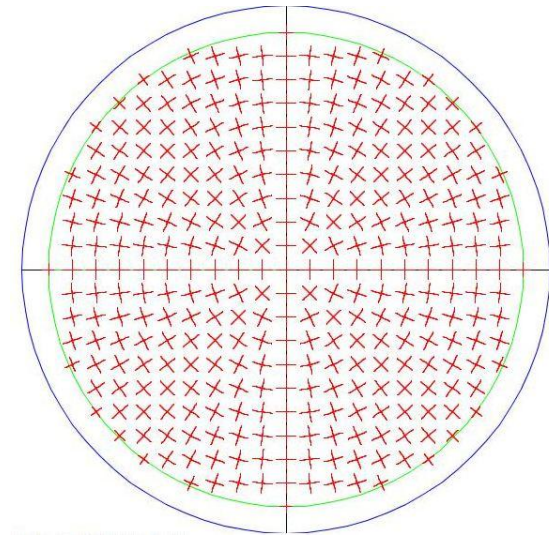
Design rule : 22nm L/S half-pitch patterns



PPT

ASML NXE:3100

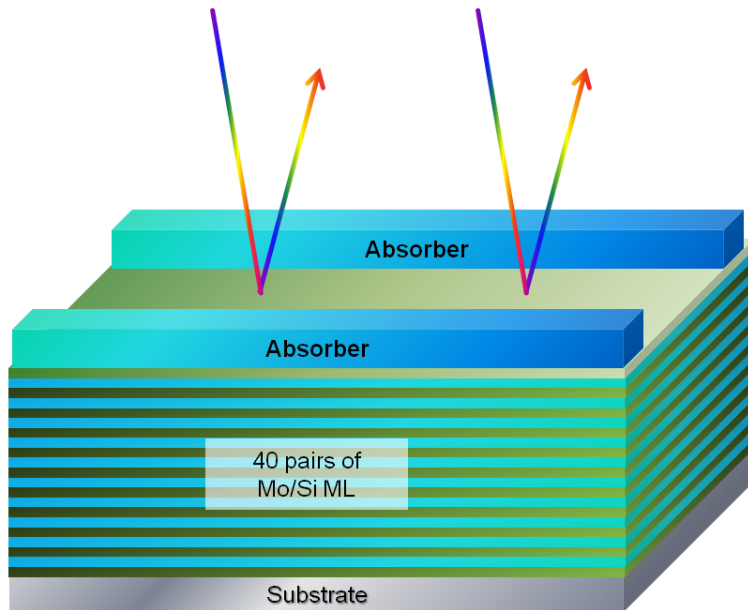
NA=0.25 σ =0.8



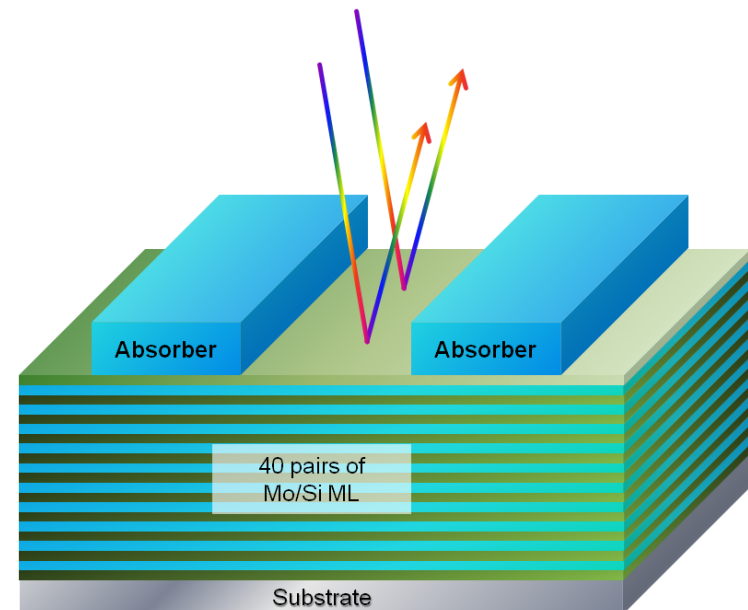
HVM

ASML NXE:3300

NA=0.33 σ =0.9

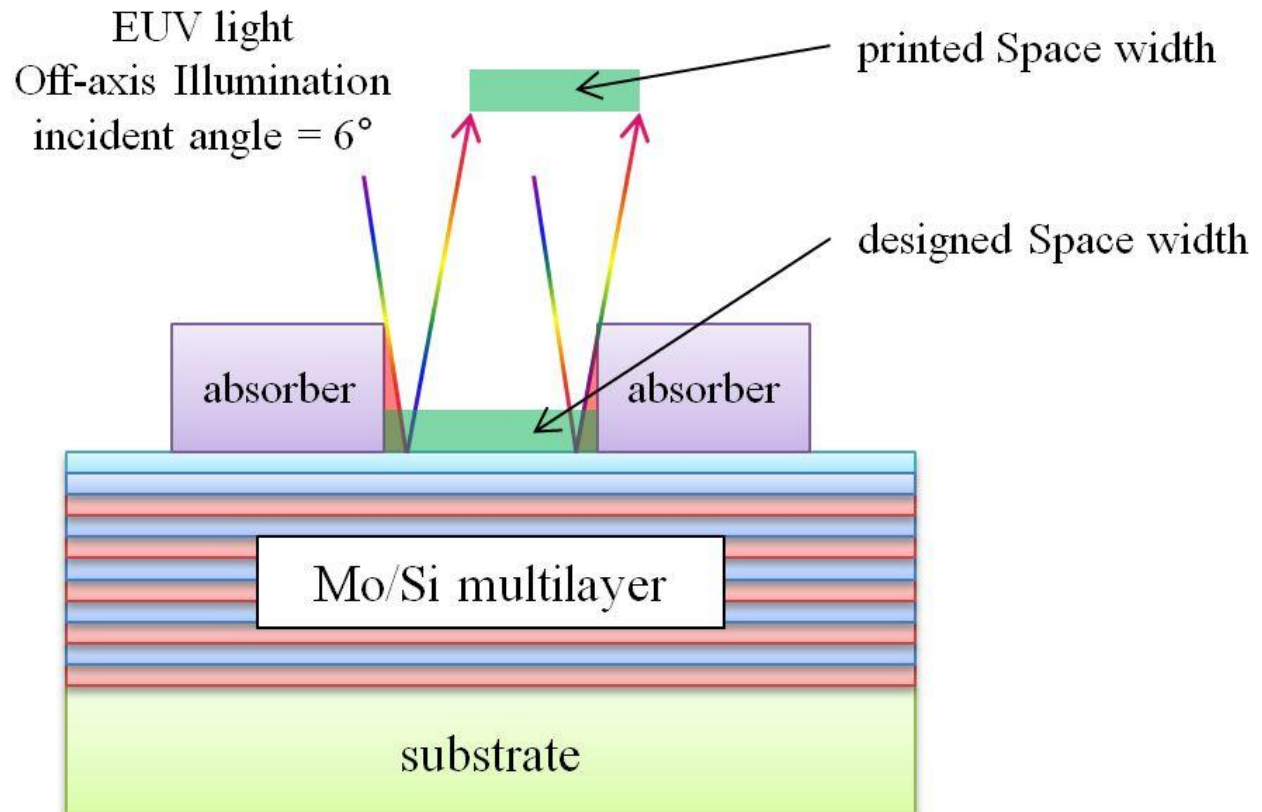


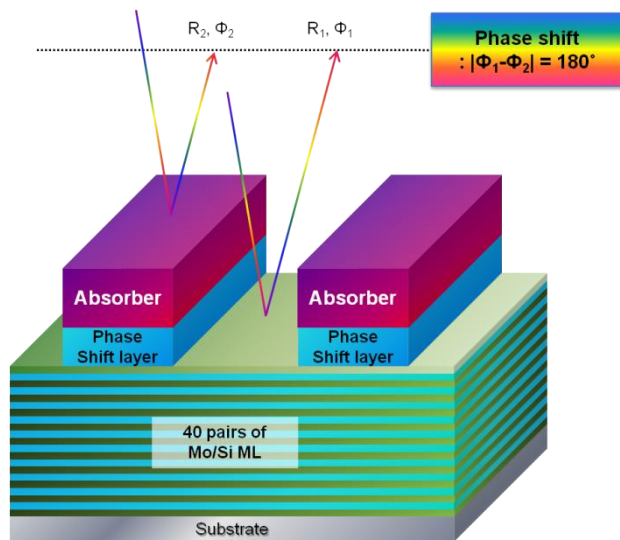
Parallel to EUV (Horizontal)



Perpendicular to EUV (Vertical)

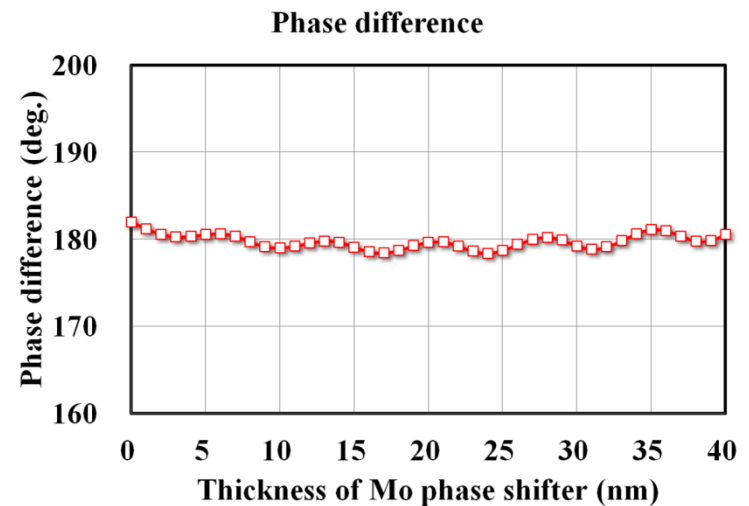
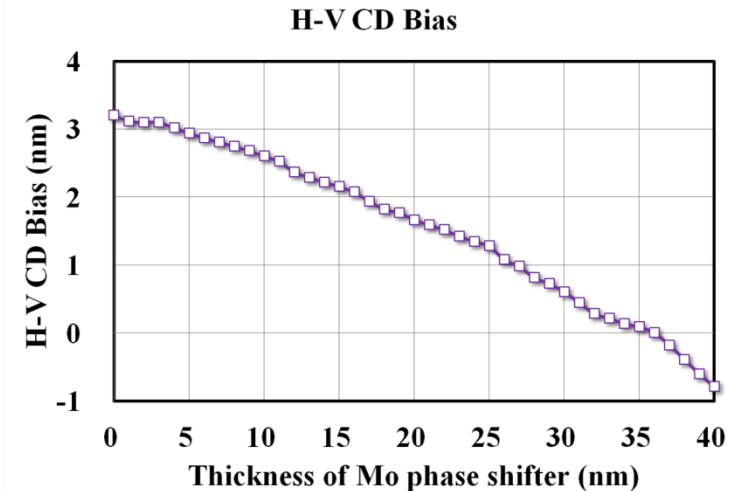
Geometrical shadowing effect





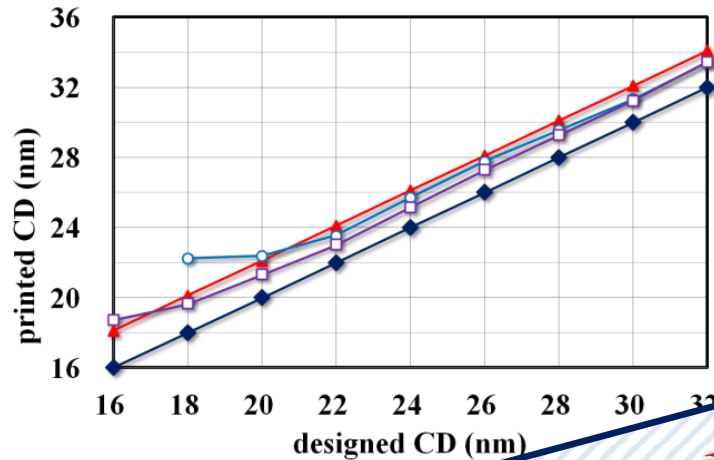
Material	δ	β
TaN	0.0730	0.0436
Si	0.0010	0.0018
Mo	0.0761	0.0064
Ru	0.1137	0.0171

Refractive index (n) = $1 - \delta + i\beta$

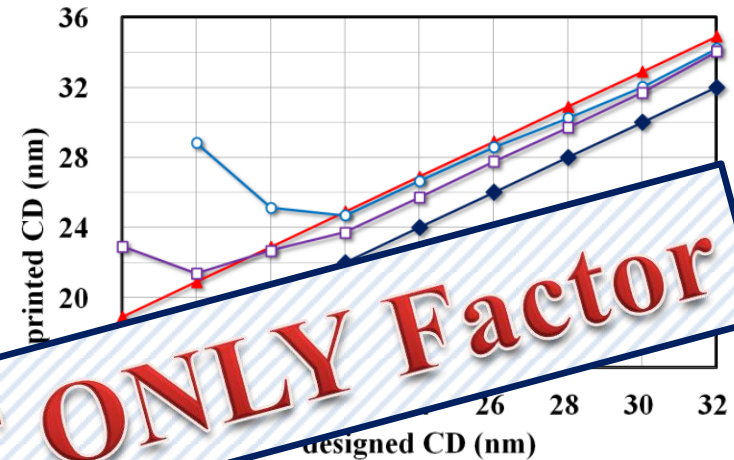


Printed CD with varying illumination

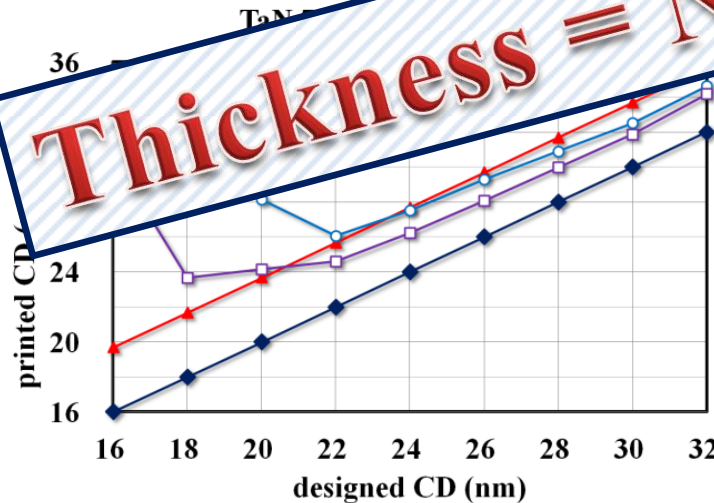
TaN 40nm absorber



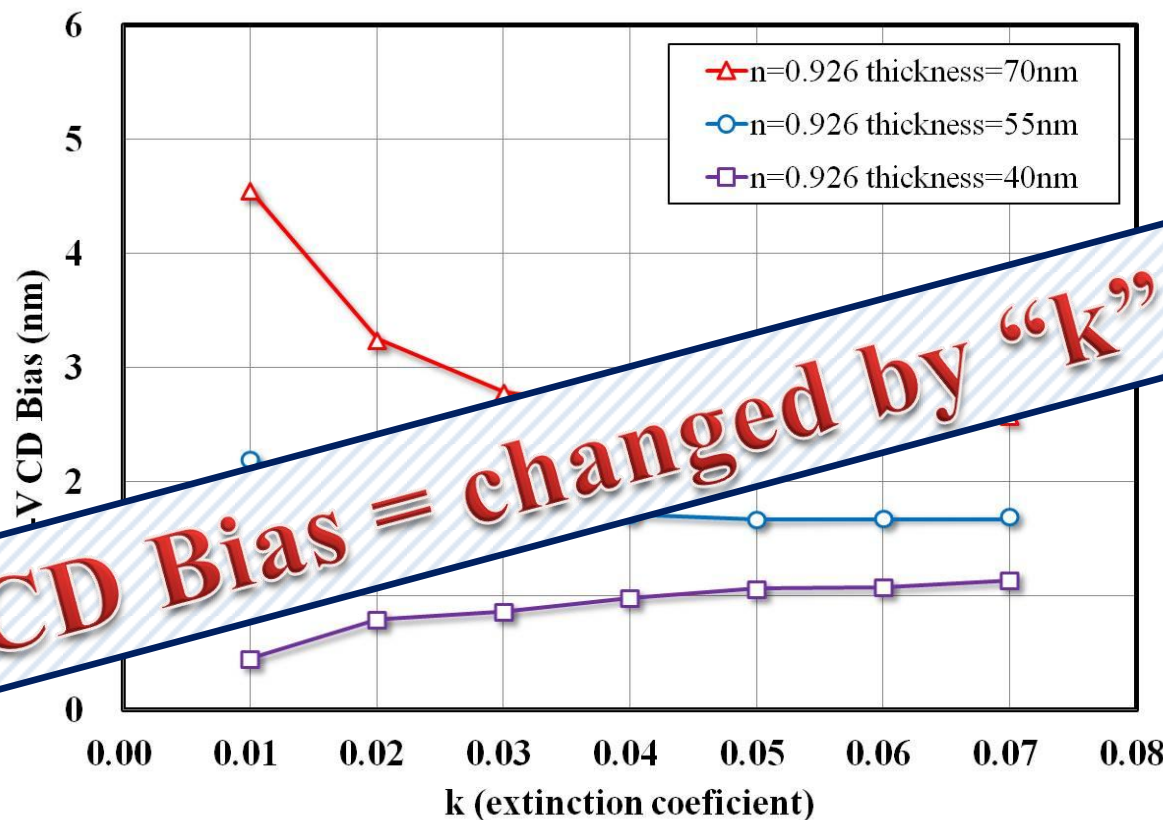
TaN 55nm absorber



Thickness = NOT ONLY Factor

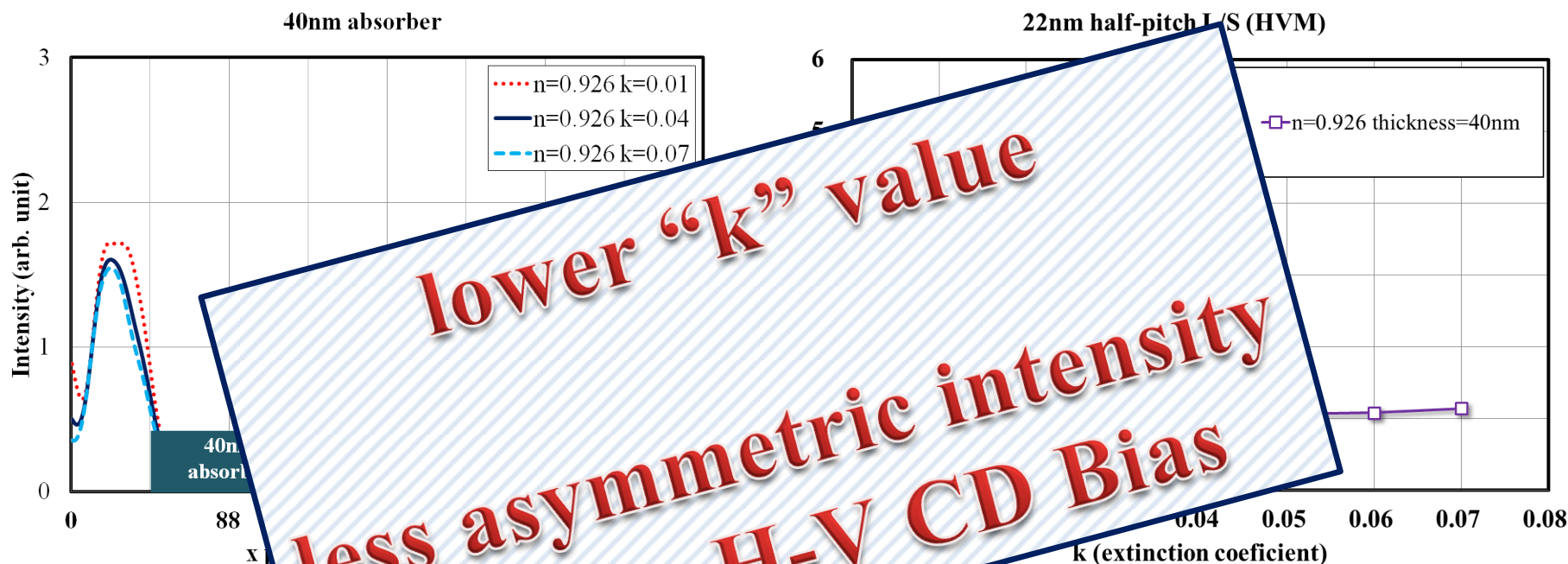


- ◆ Horizontal CD
- ▲ Vertical CD (geometric calculation)
- Vertical CD (simulation PPT)
- Vertical CD (simulation HVM)

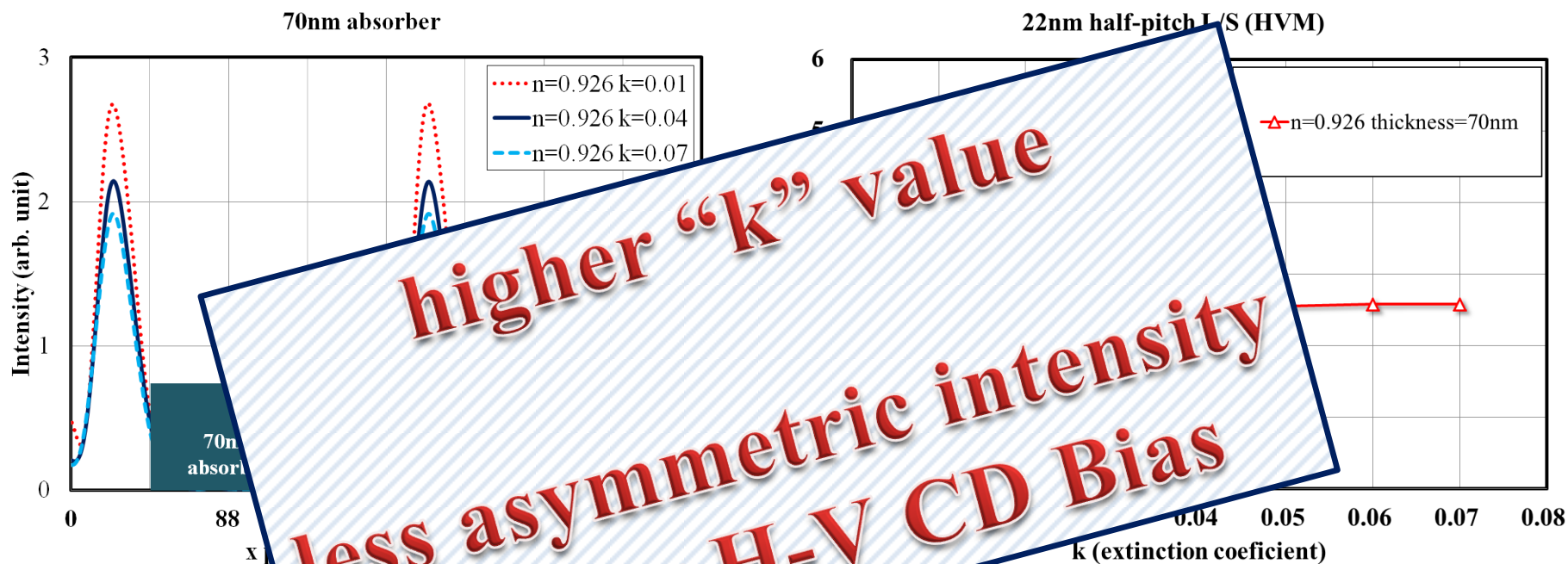


H-V CD Bias = changed by “k” value

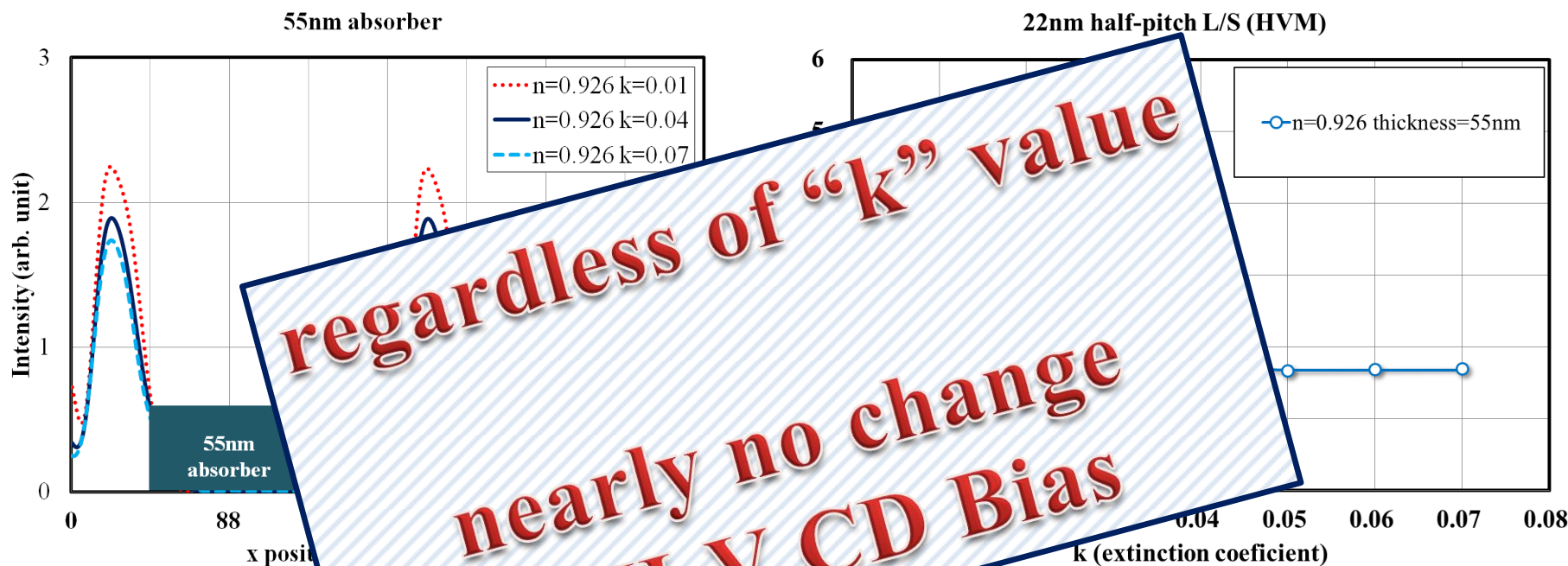
Different tendency of H-V CD Bias as functions of **absorber thickness and k value**
(for 22nm half pitch L/S patterns, HVM)



lower-k value absorber shows
less amount of asymmetric intensity between left and right side of absorber
and less amount of H-V CD Bias






higher-k value absorber shows
 less amount of asymmetric intensity between left and right side of absorber
 and less amount of H-V CD Bias



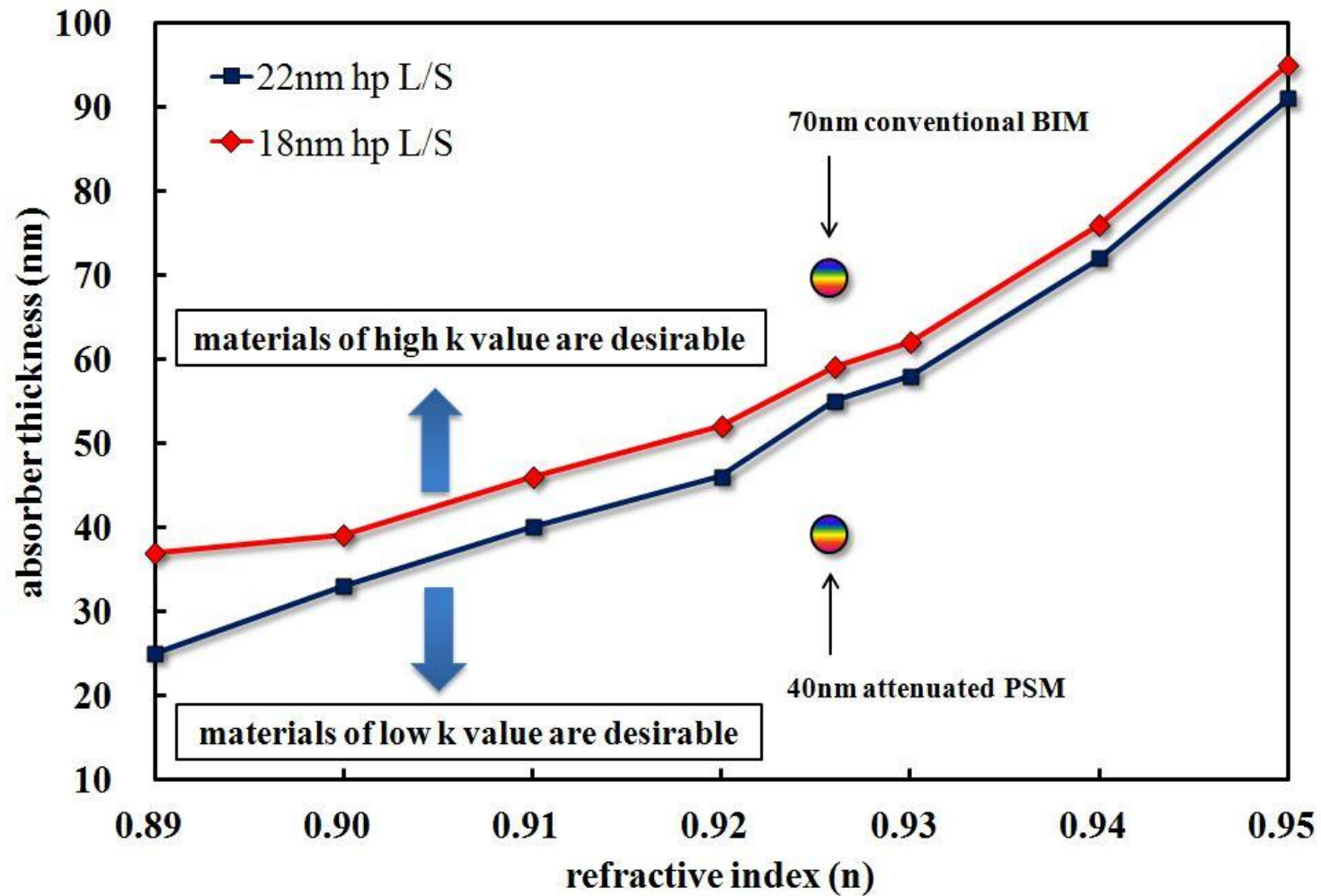
regardless of k value absorber shows
almost equally change of intensities of left and right side of the absorber
and nearly changeless amount of H-V CD Bias

for 22nm half pitch L/S patterns with HVM

Absorber thickness	Extinction coefficient (k)			H-V CD Bias
70nm	+	High value	=	
40nm	+	Low value	=	
55nm	+	Any value	=	

Guideline

for selecting absorber materials
to reduced H-V CD Bias



The factors influencing H-V CD Bias are not only **the thickness of absorber stack** but also **optical effect**

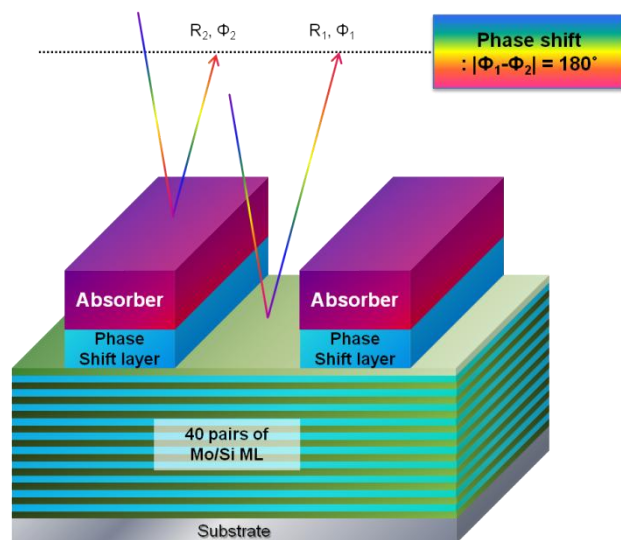
- **Illumination condition**
- **Optical constants of absorber materials**

We proposed **the guideline** for selecting absorber materials to reduce H-V CD Bias

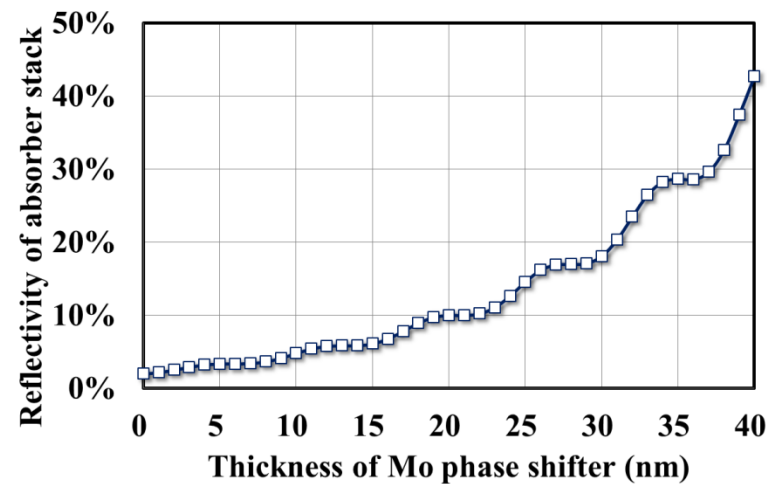
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June 4-8, 2012

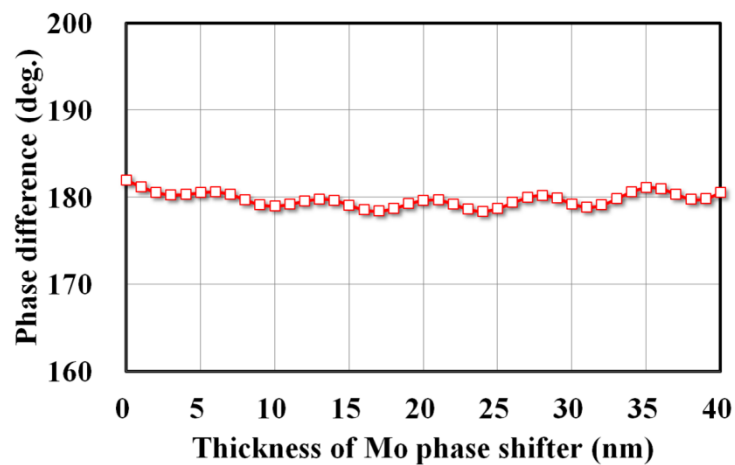
Thank you very much for your attention



Reflectivity of absorber stack



Phase difference



H-V CD Bias

